



Claims

What is claimed is:

1. (CURRENTLY AMENDED) An electronic circuit apparatus, comprising:

~~Electronic devices and their interconnection that regulates the flow of current through a battery cell storing and providing an electro motive force; An enhancement-mode JFET~~
~~An electronic switch device that blocks or allows the flow of current into and out of the battery cell, with a PN junction diode as its control gate, requiring the flow of current through it's PN junction gate to allow current flow through the channel of the device;~~
~~A dual function a capacitor connected between the control gate node of the switch device and a system ground node a reference node in the circuit; and~~ And a ~~variable-current drive~~ sub-circuit that provides variable current flow through the control gate terminal of the switch device establishing an operational state of the switch device; ~~and sub-circuits generating the required voltage to provide this variable current flow;~~ A ~~monitor-controller~~ sub-circuit that monitors the voltages at all circuit nodes and directs the ~~variable-current drive~~ sub-circuit to drive the minimum necessary current through the control gate terminal of the switch device.

2. (CANCELED) A method for current flow estimation through the channel of a gating device within an electronic apparatus regulating the flow of current, comprising:

The application of a gating device comprising of a channel and a PN junction control gate requiring forward current flow to allow current conduction through the channel;

The registration and use of voltages at all terminals of the gating device with the switch device conducting the current to be estimated;

The computation of a *compensated voltage drop* value as a mathematical combination of scaled values of the differential voltage across the channel of the switch device and the forward voltage value across its PN junction control gate diode;

And the computation of the *channel current* using known switch device characteristics and the operating condition of the switch along with the *compensated voltage drop*.

3. (CANCELED) A method for estimating device temperature within an electronic apparatus, comprising:

The application of a device with a PN junction as its control gate, where the PN junction requires a forward current through it for normal device operation;

The registration of the *forward voltage drop* across the PN junction diode control gate of the device with a known forward current supplied into the junction;

And a comparison of the *forward voltage drop* with known reference voltage values.

4. (CURRENTLY AMENDED) The apparatus of claim 1, with a ~~where a variable current drive function is performed by any~~ DC-to-DC conversion sub-circuit providing varied current flow. ~~or any current or voltage source sub-circuit.~~
5. (CURRENTLY AMENDED) The apparatus of claim 1 where the sub-circuit providing variable current flow ~~the variable current drive~~ comprises of a parallel combination of a multiplicity of charge pumps of varying current output capabilities.
6. (CURRENTLY AMENDED) The apparatus of claim 5~~4~~, ~~using one or more charge pumps for the variable current drive,~~ where the charge pump clock frequencies are varied in relation to the gating switch current flow.
7. (CURRENTLY AMENDED) The apparatus of claim 5~~4~~, ~~using a charge pump,~~ where the charge pump oscillator frequency is varied in proportion to a weighted sum of voltages across the PN junction control gate and the switch channel. ~~a continuous manner by employing a compensated voltage drop voltage as a bias voltage within the oscillator sub-circuit.~~

8. (CURRENTLY AMENDED) The apparatus of claim 1, with a shared heat-spreading element connecting the bodies of the gating switch device and the electronic system including the apparatus. ~~battery cell, such that the respective temperature values are close to each other.~~
9. (CURRENTLY AMENDED) The apparatus of claim 1 where the gating switch device is any combination of one or more enhancement-mode junction field-effect transistor (JFET) devices.
10. (CURRENTLY AMENDED) The apparatus of claim 1 employed to protect nickel-cadmium, lithium-ion, lithium-polymer or any other electric charge storage device. ~~where the gating switch device is a bipolar junction transistor (BJT) device or any combination of BJT and enhancement-mode JFET devices.~~
11. (CURRENTLY AMENDED) The apparatus of claim 1 employed to protect an electric charge storage device in the event of an over-voltage, over-current, short-circuit or other detrimental operating condition. ~~where the monitor-controller sub-circuit and the variable-current drive sub-circuit are integrated into a single monolithic component (IC).~~
12. (CURRENTLY AMENDED) The apparatus of claim 1 where ~~monitor-controller sub-circuit~~, the ~~variable-current drive~~ sub-circuit as well as the capacitor are monolithically integrated into a single component.
13. (CURRENTLY AMENDED) The apparatus of claim 1 where the sub-circuit, ~~various sub-circuits~~, the capacitor and the gating switch device are monolithically integrated into a single component.
14. (CANCELED) The method of claim 2 where the computed *compensated voltage drop* value, for a fixed switch channel current, is substantially independent of temperature.
15. (CANCELED) The method of claim 2 where the gating switch device is integrated monolithically with the reference generation circuits, providing reference switch devices

that are similar in construction for comparison, thereby enabling process invariance for the current estimation.

16. (CANCELED) The method of claim 3 where the known reference voltage values are derived in circuits using PN junction structures very similar to the PN junction gate of the switch device.
17. (CANCELED) The method of claim 3 where the device whose temperature is to be estimated and the reference generation circuits are monolithically integrated, providing identical reference devices for comparison, thereby facilitating process invariance in the temperature estimation.
18. (CURRENTLY AMENDED) Electronic systems for charging and discharge of electronic batteries ~~comprising of various integrated and discrete electronic circuits and devices, electro-chemical, electro-thermal, electro-mechanical and electro-optic devices that~~ employ the apparatus of claim 1 ~~in any embodiment.~~
19. (CANCELED) Electronic systems comprising of various integrated and discrete electronic circuits and devices, electro-chemical, electro-thermal, electro-mechanical and electro-optic devices that employ the method of claim 2 in any embodiment.
20. (CANCELED) Electronic systems comprising of various integrated and discrete electronic circuits and devices, electro-chemical, electro-thermal, electro-mechanical and electro-optic devices that employ the method of claim 3 in any embodiment.